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USE OF CLEARCUTS BY ELK IN THE LITTLE BELT MOUNTAINS, MONTANA

by

THOMAS ALFRED DAY

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE

in

Fish and Wildlife Management

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RESEARCH PROJECT

State of Montana

Project No. W-120-R3 and 4 Name Statewide Wildlife Research

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Study No. 34.01 Title Summer and Fall Elk Distribution, Movements, and Range Use in the Little Belt Mountains (Musselshell Drainage)

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Period Covered July 1, 1971 to March 31, 1973

Prepared by: Thomas A. Day
Thomas A. Day
Date April 16, 1973

Approved by: Eugene O. Allen
Wynn G. Freeman

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VITA

Thomas Alfred Day was born May 10, 1945 in Missoula, Montana to Mr. and Mrs. Alfred L. Day. He graduated from Bozeman Senior High School in June, 1963. He enrolled in the fall of 1963 at Montana State University and completed requirements for a Bachelor of Science degree in Fish and Wildlife Management in March, 1968. He was commissioned Ensign in August, 1968 from Officer Candidate School and served for two years at Kodiak, Alaska. After his release from the U. S. Navy, he began his studies at Montana State University toward a Master of Science degree in Fish and Wildlife Management. He married the former Jill Dawn Knight of Missoula, Montana in December, 1972.

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ABSTRACT

A study was conducted during two summers and one fall in the southeastern Little Belt Mountains of central Montana to obtain data pertaining to use by elk of clearcuts located in extensive stands of lodgepole pine. Secondary objectives were to record data on movements and summer distributions of two separate elk herds that winter on the south slopes and to note areas used by cattle. Ground vegetation of the lodgepole pine understory and of four groups of clearcuts; 2-4, 7-10, 11-15, and 16, 17, and 20 years of age, was evaluated from measurements within randomly spaced 2 X 5 dm. plots. Coverage values for grasses, forbs, and shrubs were greatest in the 7-10, 2-4, and 16, 17, and 20 year age groups, respectively. Elk used clearcuts only when they were located within or near traditional summer range areas. Data of observations of elk and pellet group counts in 40 intensively studied clearcut blocks indicated the most suitable conditions for elk were present when the block was located the greatest distance from human disturbance, closest to extensive stands of timber cover, adequately treated for disposal of slash, and of younger age (2-10 years). The size of opening appeared to be a negligible factor of influence. Elk were observed using 26 of the 40 clearcuts. Ninety-two percent of 1816 observations of elk using these 26 clearcuts were made in four of them. Apparently all conditions must be suitable for a block to receive appreciable elk use. Elk wintering on one area of the south slopes moved along two major routes to summer range where they concentrated activities in three main areas which they shared with elk from a larger herd that wintered on the north slopes. Elk wintering on another area of the south slopes moved along one main route to one summer area of activity upon which they were separated from the other segments. Competition between elk and cattle was relatively unimportant on higher summer range, but appeared significant on the lower winter range areas of the south slopes.

INTRODUCTION

Rising public concern with environmental quality has recently brought to light some "so-called" undesirable results of clearcut logging practices. Immediately apparent to at least some individuals are gross changes that degrade the scenic quality of our forests. Changes of a more subtle nature that may have significant effects on the quality of wildlife habitat are not revealed by casual observations. Thus the ecological effects of block clearcutting of lodgepole pine on quality of elk *(Cervus canadensis nelsoni)* (Bailey) habitat have not been completely elucidated. Investigative committees such as Bolle, *et al.* (1970), and Berntsen, *et al.* (1971) have indicated that much more information is needed concerning the relationship of elk to other resource management objectives. These groups, from qualitative observations of more or less survey types of studies, could find little evidence of either an overall adverse or beneficial effect of clearcutting on the welfare of elk, but they did find greater amounts of forage for big game following increased clearcutting.

Information concerning forage changes following clearcutting is more extensive than information concerning the effects of clearcutting and associated activities, such as road building, on the year long ecology of elk. The most extensive work of this nature was done in Oregon with the Roosevelt elk by Harper (1966 and 1971). In Montana,

two studies were conducted in the Little Belt Mountains. Kirsch (1962) studied elk use of clearcuts in summer 9 and 10 years after the first block of timber was harvested in the Deadhorse Sale Area in 1951. Coop (1971) obtained data concerning habitat use and associated behavior of elk in major drainages prior to extensive logging.

From June - September, 1971, and June - December, 1972, I collected data in this general area which would add to that compiled previously. Emphasis was placed primarily on use by elk of clearcuts in the Deadhorse Sale Area. Information concerning the movements and distribution of those elk that winter on the south-facing slopes of the Little Belts was another objective of the study. Range use of the area by livestock was also noted.

METHODS

Botanical nomenclature follows Booth (1950) and Booth and Wright (1959). Assistance in species recognition of plants was provided by comparisons with specimens in the extensive collection made by Coop from the study area in 1969 and 1970 (Coop 1971).

All vegetation sampled was within the intensively studied portion of the Deadhorse Sale Area. Using the method proposed by Daubenmire (1959), quantitative data expressing species composition of vegetation, and frequencies and canopy coverages of individual taxa less than one meter in height were collected and analyzed. Twenty or forty 2 X 5 decimeter plots spaced 15 to 50 paces apart were evaluated in each clearcut or lodgepole timber stand sampled. Numbers of plots and spacing between plots were roughly proportional to the size of the vegetation stand sampled. Shape of vegetation stands dictated the pattern of plot locations to adequately cover all portions. Data were also collected at plots established and evaluated in 1961 by Kirsch (1962) in both clearcuts and mature timber stands. Differences in forage production between stands of mature lodgepole pine and clearcuts of varying ages were shown by average canopy-coverage values for forage classes (Daubenmire 1959). These data also indicated successional changes.

At the location of each vegetation plot in clearcuts elk, deer, and cattle pellet groups within an 11.7' radius circle, 1/100 acre,

were counted and classified as to time of deposition (current or previous years). These recordings were converted to pellet groups/ acre to provide a comparative index of animal use.

Physical characteristics of clearcuts including cutting and thinning dates, slopes, elevations, aspects, and tree regeneration measurements were compiled from U. S. Forest Service records. Recent aerial photographs were used to calculate acreages of separate clear-cut blocks. Approximate areas were determined using a dot grid.

Thirty-three elk wintering on the south-facing slopes have been marked for individual identification since the winter of 1970. Fifteen elk were marked with 3" neckbands similar to those described by Knight (1966), and 18 were marked with a 6" pattern. In addition, a large number of elk had been marked on the Judith Game Range during previous years.

Distribution, movements, and use of individual clearcuts were determined by recording the locations of marked and unmarked animals observed. Group size, sex, age, and activity of the elk were also recorded. Foot and vehicle travel provided the modes of transportation while making observations. Aerial observations from a 150 Super Cub were scheduled on a monthly basis during the first summer of study and weekly when practical during the second summer and fall. A 25-60 X spotting scope and a 7 X 50 binocular aided in making observations.

Cattle allotment boundaries, numbers of cattle present, and dates of use of lands suitable for elk during any season were provided from U. S. Forest Service records. Cattle distributions were secondarily noted during observation periods and aerial flights.

STUDY SITE

Gieseker *et al.* (1953) described the 1,648 square mile area comprising the Little Belt Mountains as being formed by a broad folded-arched uplift which has been eroded and dissected to produce rounded peaks and deep rock-walled canyons with limestone of carboniferous age exposed on the northern and southern slopes. The study area of approximately 250 square miles lies in the southeastern portion (Figure 1). Latitudinal boundaries were the Higgins Park area on the west and the East Fork of Haymaker Canyon on the east. The Lewis and Clark National Forest Boundary was the southernmost extremity. Prominent features of the northern boundary were High Mountain, Dry Pole Canyon, Ettien Ridge Road, and the West Fork of Lost Fork. Twenty square miles of the Deadhorse Sale Area which lies between the Musselshell and Judith River drainages were designated an intensive study portion (Figure 2). Boundaries were the East Fork of Lion Creek on the west, Spring Creek Road on the east, the Forest Boundary on the south, and the heads of Corral and Big Hill Creeks and Hoover Springs on the north. Previous work (Kirsch 1962) indicated heavy use by elk of clearcuts in this area. It contained 62 clearcut blocks which form 34 separate entities because of adjoining edges. The blocks varied from 2-20 years of age and 7-104 acres in size.

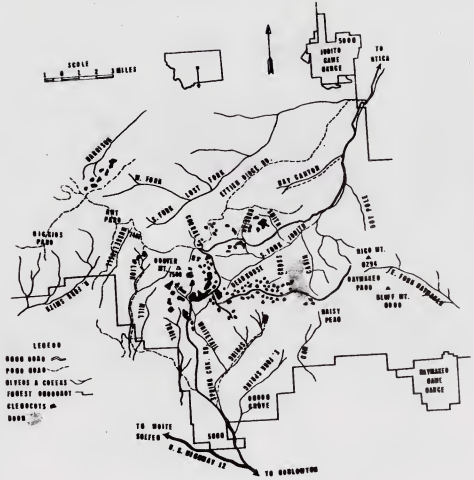


Figure 1. Map of study area showing distribution of clearcut areas.

Figure 2. Map of intensive study area showing distribution of clearcut blocks. The blocks receiving the most use by elk are designated A, B, C, or D. Ages are for the first summer of study.

Kirsch (1962) recognized four major vegetation zones in the Little Belt Mountains: ponderosa pine-grassland *(Pinus ponderosa)*, ponderosa pine, Douglas-fir *(Pseudotsuga menziesii)*, and Engelmann spruce-subalpine fir *(Picea engelmannii-Abies lasiocarpa)*. The latter two zones were represented on the intensively studied portion of the study area. The Douglas-fir zone extended a little beyond 7,000 feet on the xeric southern slopes, while the spruce-fir zone rose upwards to Hoover Mountain, 7,500 feet in elevation, and down the mesic north slopes that drain to the South Fork of the Judith River. Most of each of these zones was in a subclimax stage with lodgepole pine *(Pinus contorta)* in dense closed canopy stands.

All vegetation measurements were within Township 11 North, Range 10 East of the Sale Area. Leiberg (1904) listed 20,000 acres of this township as forested, 3,040 acres as nonforested, and 3,000 acres as badly burned. Mature lodgepole pine varying in age from 50-200 years accounted for 91.8 percent of the forested land. A 1963 Forest Service Timber Inventory Map shows an overstory of Douglas-fir for small portions along the southern boundary and small stands of Engelmann spruce along a few of the drainage bottoms. Some large natural open parks and burn areas are located at the western edge on a ridge running from the heads of Mill, Trail, and Whitetail Creeks to an area three miles north of Hoover Mountain. Most of the remainder of the township that has not been block clearcut is classified as well stocked, 70-100 percent,

mature lodgepole pine sawtimber of the nine inch d.b.h. stand size class. Casual observations indicated tree height to center around 60 feet with 80 percent closed canopy coverage.

Three major elk wintering areas are located at varying distances from the Deadhorse Sale Area. Approximately 1,000 elk winter on the Judith Game Range and adjacent lands some nine miles to the north, while 400 elk winter on the south slopes and concentrate in two areas. The Spring Creek-Round Grove area, six miles to the south serves to winter 200 head and an equal number use lands near Haymaker Game Range 15 miles to the southeast (Figure 1).

RESULTS

Vegetation

Vegetation of the Mature Lodgepole Pine Understory

Except for shrubs, sparse understory vegetation existed under the closed canopy of the mature lodgepole pine forest (Table 1). Coop (1972) found the number of species for the understory of lodgepole pine to be less than for each of three other timber types. He and Kirsch (1962) found 17 and 15 genera respectively, including elk sedge *(Carex geyeri)*, in the understory of lodgepole pine. I recognized 17 genera, none of which were grasses or grass-like plants.

Nine genera of forbs were recorded. Pussytoes *(Antennaria* spp.*)*, heartleaf arnica *(Arnica cordifolia)*, and aster *(Aster* spp.*)* were the most abundant, but each had less than one percent coverage. Common pipsissewa *(Chimaphila umbellata)* and pinedrop *(Pyrola chlorantha)* were the only forbs recorded in the understory that were absent in clearcuts.

Seven genera of shrubs were recorded with two species of huckleberry accounting for over 85 percent of the total canopy coverage of this forage class. Thinleaved huckleberry *(Vaccinium membranaceum)*, with one-third the coverage value, was two-thirds as abundant as the most important understory plant, low red huckleberry *(Vaccinium scoparium)*. Spiraea *(Spiraea* spp.*)* was the only other shrub with a coverage of over one percent.

TABLE 1. CANOPY COVERAGE, FREQUENCY, AND CONSTANCY OF TAXA FOR FORBS AND SHRUBS OCCURRING IN THE MATURE LODGEPOLE PINE UNDERSTORY AS INDICATED BY MEASUREMENTS FROM ONE HUNDRED AND TWENTY 2 X 5 DECIMETER PLOTS ON THREE DIFFERENT SITES.

Taxa	
Forbs	3/32/100[1]
Antennaria racemosa	.6/10/67
Arnica cordifolia	.5/7/100
Aster spp. *foliaceous*	.5/7/33
Chimaphila umbellata	tr[2]/3/33
Epilobium angustifolium	tr/1/33
Hedysarum sulphurescens	tr/2/33
Heiracium albiflorum	tr/3/33
Pedicularis groenlandica	tr/1/33
Pyrola chlorantha	tr/1/33
Unidentified forb	.5/9/100
Shrubs	34/86/100
Berberis repens	tr/3/33
Juniperus spp.	.9/4/100
Linnaea borealis	.6/5/67
Rosa spp.	tr/1/33
Spiraea spp.	3/24/67
Symphoricarpus spp.	tr/1/33
Vaccinium membranaceum	8/43/100
Vaccinium scoparium	21/60/100

[1]Canopy coverage (percent of area covered)/average frequency (percent occurrence among plots)/constancy (percent occurrence among sites).

[2]tr = Trace; a value less than .5 percent.

Ground Level Vegetation of Clearcuts

A complex arrangement of factors could influence the abundance and variety of vegetation that follows the opening of the forest canopy by the block clearcut method of logging. The most evident factors of influence are the greater amounts of sunlight intensity and precipitation that reach the ground level vegetation. Vegetation of clearcuts of the same age was often quite different. Some of the factors producing this heterogeneity were variations in slope, aspect, and soils. More subtle factors exist which produce differences in the vegetation that follows clearcutting, such as the different treatments used in cleaning up logging debris. For a discussion of other influencing factors, the reader is referred to Pengelly (1966), Lotan (1964), Basile and Jensen (1971) and Vogl and Ryder (1969). In my evaluation I considered only the influence of age of clearcuts in evaluating ground vegetation. Results from the examination of the vegetation within eight hundred and ten 2 X 5 dm plots from June to September 1971 and 1972 are considered. Data were tabulated separately for each age of clearcuts as shown in Appendix Tables 12, 13, 14, 15, and 16. These data were further combined into four age groups of clearcuts; 2-4, 7-10, 11-15, and 16, 17, and 20 years of age (Table 2). Productivity changes and successional trends are expressed by coverage values. Frequencies and constancies indicate distributions as well as successional trends.

TABLE 2. PERCENT CANOPY COVERAGE, FREQUENCY, AND CONSTANCY OF LOW-GROWING TAXA IN FOUR AGE GROUPS OF CLEARCUTS; 2-4, 7-10, 11-15, AND 16, 17, AND 20 YEARS AFTER CUTTING AS DETERMINED BY EXAMINATION OF TWENTY, FORTY, OR FIFTY 2 X 5 DECIMETER PLOTS AT EACH CLEARCUT EXAMINED.

Age Group	Youngest	Second	Third	Oldest
No. of Clearcuts	6	6	9	7
No. of Plots	200	180	200	230
Age of Clearcuts	2-4	7-10	11-15	16,17,20
Taxa[1]				
Grasses	7/47/100[2]	16/67/100	10/69/100	7/44/100
Agropyron spp., *spicatum, repens*	tr[3]/2/33	3/13/75	3/9/40	tr/tr/50
Agrostis scabra	1/10/67	1/3/50	.6/7/40	.5/4/50
Bromus spp., *marginatus, inermis*	--	2/11/100	tr/2/80	--
Festuca spp., *idahoensis, scabrella*	2/9/67	2/12/75	3/16/100	2/9/100
Phleum spp., *pratensis, alpinum*	--	1/3/25	tr/tr/20	tr/1/50
Poa spp.	2/4/33	.8/7/25	tr/2/40	--
Trisetum spicatum	.8/5/100	3/20/50	2/19/80	2/19/75
Unidentified grasses	1/17/100	2/11/100	1/20/100	2/17/100
Forbs	37/91/100	35/97/100	33/95/100	24/87/100
Achillea millefolium	tr/6/67	.9/12/100	.7/13/80	--
Antennaria spp., *racemosa, rosea, parvifolia*	tr/4/67	2/21/75	2/24/100	2/23/75
Arnica cordifolia	6/37/67	1/26/100	2/28/100	tr/7/50
Aster spp., *foliaceus*	8/37/100	8/48/100	9/52/100	5/30/100
Astragalus spp., *miser*	4/18/100	.9/8/100	1/10/80	tr/4/50
Campanula rotundifolia	--	tr/2/50	tr/5/60	tr/4/75
Cirsium spp., *arvense, undulatum, canovirens*	2/16/100	3/23/75	tr/1/20	--
Collomia linearis	--	--	tr/6/20	--
Epilobium angustifolium	tr/5/100	3/22/100	2/21/100	5/48/100
Galium boreale	3/27/100	2/18/100	tr/9/20	tr/2/50
Geranium spp., *viscosissimum, richardsonii*	2/16/100	1/9/100	.6/9/60	tr/3/75
Hedysarum sulphurescens	.5/4/67	--	1/9/80	1/6/50

TABLE 2. Continued.

Age Group	Youngest	Second	Third	Oldest
No. of Clearcuts	6	6	9	7
No. of Plots	200	180	200	230
Age of Clearcuts	2-4	7-10	11-15	16,17,20
Taxa				
Forbs (Continued)				
Hieracium albiflorum	tr/4/33	tr/9/50	1/22/80	1/25/75
Lupinus argenteus	2/13/67	2/16/100	7/38/80	7/37/100
Lycopus asper	.7/3/67	--	--	--
Mertensia spp., *oblongifolia*	--	.9/7/75	--	--
Penstemon rydbergii	1/7/67	tr/4/75	tr/4/60	--
Potentilla spp.,*gracilis, arguta, ovina*	.6/4/67	tr/2/50	tr/4/40	tr/tr/25
Senecio spp., *canus*	tr/5/33	--	--	--
Taraxacum officinale	1/17/100	3/33/100	2/28/80	tr/6/75
Thalictrum venulosum	3/12/67	.7/7/75	1/5/40	--
Trifolium spp.	--	2/3/50	--	tr/2/50
Unidentified forbs	tr/4/100	tr/4/50	tr/5/80	tr/3/100
Shrubs	23/81/100	17/74/100	23/86/100	34/95/100
Arctostaphylos uva ursi	.6/2/33	--	--	--
Berberis repens	3/27/100	3/23/100	2/18/80	.6/3/25
Frageria spp., *virginiana*	5/35/100	7/41/100	4/23/80	1/10/100
Juniperus spp., *communis*	tr/2/67	--	.7/4/80	2/5/75
Linnaea borealis	tr/2/67	--	tr/tr/20	1/6/50
Rosa spp.	3/17/100	2/14/100	2/13/100	.6/5/100
Spiraea spp.	8/52/100	2/23/100	6/54/100	5/43/75
Symphoricarpus albus	2/14/67	--	.5/4/40	.5/2/50
Vaccinium membranaceum	--	.8/9/50	2/16/80	5/30/100
Vaccinium scoparium	.6/9/33	2/12/50	5/29/100	18/65/100
Sedges - *Carex* spp., *geyeri*	10/41/100	14/43/100	13/56/100	13/51/100
Bare Ground	14/37/100	14/51/100	18/44/80	6/25/100
Rock	--	tr/3/50	3/21/80	3/15/67
Litter	83/100/100	82/100/100	80/100/100	89/100/100

TABLE 2. Continued.

[1]Includes those taxa with a canopy coverage of .5 percent or greater or a frequency of 5 percent or greater in at least one age group of clearcuts. Others are listed in Appendix Tables 12, 13, 14, 15, and 16.

[2]Canopy coverage (percent of area covered)/average frequency (percent occurrence among plots)/constancy (percent occurrence among clearcuts of different ages in that age group).

[3]tr = Trace; a value less than .5 percent.

There was little diversity of grasses among the age groups of clearcuts. Eight genera were recognized in all age groups except the third (11-15 years) with 11. Fescue *(Festuca* spp.*)* and spike trisetum *(Trisetum spicatum)* were the most uniformly distributed and had the highest coverage values. Coverage reached a peak in the second age group (7-10 years) and then steadily decreased (Figure 3), probably due to the increasing overstory of lodgepole pine as the clearcuts aged.

Fifty-two genera of forbs were recognized in clearcuts with 11 of them containing two or more species. The greatest number of genera was found in the second age group and the least number in the oldest age group. Aster had the highest recorded coverage and frequency values in all age groups except the oldest in which silvery lupine *(Lupinus argenteus)* exhibited the highest values. Coverages of some genera including heartleaf arnica, northern bedstraw *(Galium boreale)*, and sticky and Richardson geranium *(Geranium* spp., *viscosissimum, richardsonii)* generally decreased with increasing age of clearcuts, while coverage of others such as silvery lupine and fireweed *(Epilobium angustifolium)* increased. Total aggregate canopy coverage of forbs decreased slightly from the youngest to the third age group, and then a sharp drop was noticed in the oldest age group indicating an increased rate in successional trend toward values comparable to the understory of the mature forest.

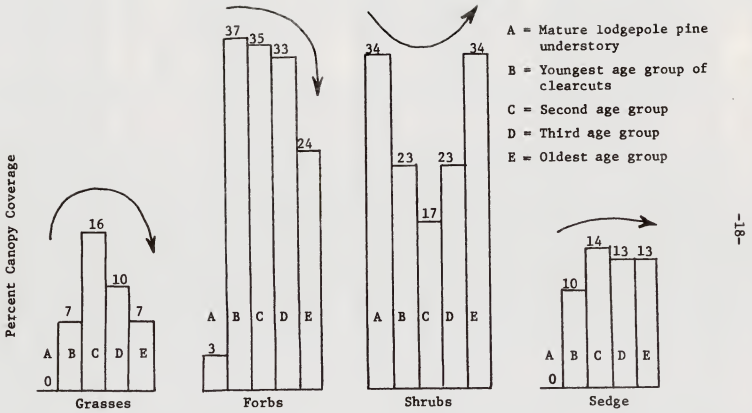


Figure 3. Comparison of canopy coverage data of ground level vegetation by forage class of the mature lodgepole pine understory and clearcuts of four age groups; 2-4, 7-10, 11-15, and 16, 17, and 20 years. Successional trends are indicated by arrows.

Fourteen genera of shrubs were recognized with little variation among age groups of clearcuts. Coverages of low red and thinleaved huckleberry steadily increased as the clearcuts aged. There was no discernible successional pattern exhibited by the other genera present. Aggregate total canopy coverage of shrubs steadily decreased from the timber understory to the second age group of clearcuts and then rose to a value equal to that of mature timber in the oldest age group, mainly due to the increase in low red huckleberry.

Recorded values for canopy coverages and frequencies for elk sedge varied little between age groups of clearcuts.

Basile and Jensen (1971) examined 25 clearcuts ranging from 2-17 years of age in lodgepole pine forests within the Lewis and Clark and Gallatin National Forests, and used regression analysis to compare herbage yields of ground level vegetation. Total production of ground level vegetation reached its peak about 11 years after clearcutting. My results differed from theirs for the production of two forage classes. They found grasses peaked at 13 years after cutting and shrubs increased over the entire span of time. Similar findings were indicated for forbs, which peaked at 10 years, and sedge, which showed no discernible pattern.

Use of Clearcuts by Elk

Seasonal Use of Clearcuts

Data comparing the percentage of elk observed using clearcuts to other areas for 24 aerial flights indicated most use occurred from June to mid-August (Table 3). An attempt was made to cover all portions of the study area (Figure 1) during each flight. Ground observations indicated later use of clearcuts by elk, but are more biased because of the emphasis put on observing clearcut areas (Table 3). A sharp drop in elk seen per observation trip, both ground and air, was noted after mid-August indicating more use of timbered areas and less use of openings, including clearcuts, as forage became dessicated. Kirsch (1962) observed fewer elk in August than during any other month, although he made the greatest number of observational trips during that month. Hunting season began after mid-October and lasted until the end of November and few elk per observational trip were observed through this period.

Importance of the Location of Logging Areas

Two clearcut Sale Areas, one located west of Spring Creek Road in the Deadhorse Area and the other at the head of Smith Creek in the Russian Creek Area, received relatively heavy elk use if compared to other clearcut areas (Figure 1). These two lie in close proximity to areas interspersed with heavy timber cover, natural openings, and

TABLE 3. USE OF CLEARCUTS BY ELK DURING DIFFERENT SEASONS AS DETERMINED DURING AERIAL FLIGHTS AND GROUND OBSERVATIONS (INCLUDES DUPLICATE OBSERVATIONS OF THE SAME ANIMALS).

Period[1]	Number of Aerial Flights	Number of Elk Observations From Air			Elk Seen Per Flight	No. of Ground Trips	Number of Elk Observations From Ground			Elk Seen Per Trip
		Total	In Clearcuts No.	In Clearcuts % of Total			Total	In Clearcuts No.	In Clearcuts % of Total	
June 8-15	-	---	--	-----	-----	11	76	49	64.5	6.9
June 16-30	1	155	52	33.5	155.0	35	371	240	64.7	10.6
July 1-15	2	246	122	49.6	123.0	32	575	398	69.2	18.0
July 16-31	3	157	84	53.5	52.3	27	339	281	82.9	12.6
Aug. 1-15	3	407	118	29.0	135.7	32	479	408	85.2	15.0
Aug. 15-31	3	243	0	0.0	81.0	26	186	134	72.0	7.2
Sept. 1-15	3	65	4	6.2	21.7	40	149	121	81.2	3.7
Sept. 16-30	2	9	1	11.1	4.5	25	70	9	12.9	2.8
Oct. 1-15	2	30	10	33.3	15.0	14	78	40	51.3	5.6
Oct. 16-31	1	32	10	31.3	32.0	9	32	10	0.0	3.6
Nov. 1-15	3	16	0	0.0	5.3	10	45	0	0.0	4.5
Nov. 16-30	1	6	0	0.0	6.0	13	6	0	0.0	0.5

[1]Data for June-Sept. for 1971 and 1972; Oct.-Nov. for 1972 only.

mesic meadows. Undoubtedly, elk summered in these areas prior to logging, and consequently, had to make only minor adjustments in use of feeding areas to make use of additional forage resulting from clearcutting.

Few elk were observed in the cutover area east of Spring Creek Road. Prior to logging, it appeared as a flattened, 30 square mile area of mature lodgepole pine with a paucity of natural openings; characteristics which lend little to summering large numbers of elk. During the last 20 years, approximately 100 clearcut blocks have been produced in this area with a resultant greater amount of timber - opening interspersion, but few elk have responded to the change. Perhaps there has been too little time for elk to pioneer this area. The evidence points to the fact that in the Little Belts, elk have made use of clearcut areas located near traditional summer range, and have not been enticed into other logged areas regardless of increased forage available in clearcuts.

Use of Clearcuts by Elk in Relation to Other Factors

Data were tabulated from June through September for 40 clearcut blocks located west of Spring Creek Road (Figure 2). They formed only 31 separate openings because of the logging practice of cutting blocks adjacent to previously cut areas. Values used to express relative degrees of elk use of clearcuts were: (1) total elk observed; (2) elk

observed/acre; (3) frequency of use by elk as expressed by the percent of early morning and late evening observations that resulted in my seeing at least one elk; and (4) intensity of use as measured by pellet groups/acre deposited during both current and previous years.

Importance of Location of the Clearcut Block in the Logging Pattern and Distance from Extensive Cover and Major Road Systems

Elk were observed using 26 of the 40 clearcut blocks. Of the 1,816 observations of individual elk, 92 percent, 1,673, were recorded as using one or the other of four blocks which together accounted for only 25 percent of the total acreage of clearcuts (Table 4). Thirty-two percent of 314 observations of these four blocks resulted in sightings of elk. Elk were seen during only three percent of the 1,251 observations of the other 36 blocks. Group sizes recorded for the four most used clearcuts were frequently 20 to 40 or more, while those in the other blocks were more commonly one or two elk. Kirsch (1962) and Coop (1971) also reported that a small percentage of the blocks in a local area received the greatest use.

These four blocks that received the most usage during my study had at least three ingredients in common with reference to their location. All were located further away from Spring Creek Road, an area of human activity, than any other blocks in their respective small drainages (Figure 2). All were located at the drainage heads or on a ridge that

TABLE 4. VALUES FOR COMPARISON OF ELK USE OF THE FOUR MOST USED CLEARCUT BLOCKS. BLOCKS ARE RANKED FROM GREATER TO LESSER USE ON THE BASIS OF TOTAL ELK OBSERVED.

Block Ranking	Age in Years	Size in Acres	Total Number of Elk Observed	Elk Observed Per Acre Per Year	Percent[1] Frequency of Use By Elk	Pellet Groups/ Acre - Year of Deposition	
						Current	Previous
A	7-8	85	1,034	6.08	39	78	48
B	2-3	43	323	3.76	33	115	88
C	8-9	104	181	0.87	30	38	103
D	7-8	65	135	1.04	20	20	65

[1]Percent of observations during which elk were observed.

crosses above them (Figure 4). Large areas of extensive heavy timber cover lay behind their most westerly edges, and elk mostly entered the blocks from these edges in the evenings and returned to these cover areas in the mornings or when harassed. Road systems had not been developed through these extensive cover areas except for a few 4-wheel drive trails which were seldom used during the summer.

Use by Elk of Clearcuts of Various Ages as Correlated with Vegetation and Food Habits

Data of the 40 blocks used in analysis were combined into one or the other of four age groups (Figure 8) to facilitate comparison with the age groups used in describing the vegetation (Table 2). During the second summer of study, five of the blocks advanced to the next older age group and data were adjusted accordingly. The two youngest age groups, 2-4 and 7-10 years, had the highest recorded

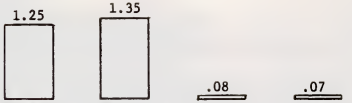
Figure 4. Clearcut A, located at the head of Whitetail Drainage.

Figure 5. Clearcut heavily laden with slash, located at the head of Lion Creek.

Figure 6. Green Mountain Thinning Study; 14 blocks forming 251 acres of opening.

Figure 7. Mesic meadow, located on the east face of Green Mountain, where Kirsch (1962) made most observations of elk.

a.) Elk observed/acre/year.

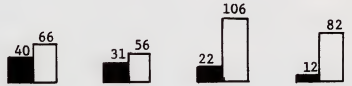


Age Group	Youngest	Second	Third	Oldest
Age (years)	2-4	7-10	11-15	16,17,20
No. cuts examined	4	13	10	18
Total acreage examined	136	516	190	397
No. elk observed	341	1,391	32	52

b.) Frequency of use (percent of observations resulting in sighting of elk)

Age Group	Youngest	Second	Third	Oldest
No. observations	40	87	11	9

c.) Pellet Groups/Acre



Age Group	Youngest	Second	Third	Oldest
No. Cuts Examined	4	6	9	6
No. Plots Examined	140	180	200	190

Time of Deposition

■ Current year
□ Previous years

Figure 8. Use of each of four age groups of clearcuts by elk as indicated by elk observed/acre/year, frequency of use as expressed by percent of observations resulting in sighting of elk, and pellet groups/acre.

values for elk observed per acre and frequency of use by elk (Figures 8a and 8b). Comparison of Table 4 and Figure 8 reveals the influence on these data of the four most used clearcuts which are included in the two younger age groups. Data of pellet group counts (Figure 8c) indicated a more uniform distribution of elk use between the age groups. The highest value for currently deposited pellet groups per acre was calculated for the youngest age group, undoubtedly because of the high count in the two year old clearcut B (Table 4). The values steadily decreased to the oldest age group. The greatest value for pellet groups per acre deposited prior to the summer of sampling occurred in the 11-15 year age group. Although the time for pellet disintegration is not known, this value, when compared to the lower value for the oldest group of clearcuts, suggests greater usage of the younger clearcuts. A number of investigators have reported that elk use varied with different ages of clearcuts. In Oregon, Harper (1966) and Swanson (1970) indicated peak elk use occurred 5-7 and 5-9 years after cutting, respectively. In the Little Belts, Kirsch (1962) reported that blocks 7-8 years of age received 57 percent of the total usage of all clearcuts by elk groups, but comprised only 22 percent of the total blocks; and Coop (1971) found in the Russian Sale Area that three blocks, averaging 8-10 years of age, received 88 percent of the observed elk use but most blocks in this locality were of that age.

Feeding was the principal activity of elk observed in clearcuts during early morning and late evening daylight periods. During darkness, the blocks were used for bedding areas as well as evidenced by the presence of fresh beds and observations of marked elk. Marked elk were observed leaving the same blocks in the mornings following evening observations. Published data on elk food habits for this general area (Kirsch 1962), when correlated with the occurrence of vegetation, expressed as forage classes of different aged cuts (Figure 3) partially explains the preference of elk for cuts 2-10 years of age. Kirsch (1962) used feeding site examinations to describe the food habits of the elk of this mountain range during the summer period, June through August, and then separated a portion of the data (Kirsch, no date) into foods eaten in the Deadhorse Sale in clearcuts and adjacent park like areas. I used these data to construct Table 5 for comparison of vegetation in the diet with vegetation of different age groups of clearcuts (Figure 3) and also with the vegetation of the four most used blocks (Table 6). Forbs were the preferred forage class during summer (Table 5). This forage class was most abundant in the two younger groups of clearcuts (Figure 3). The relatively higher use of shrubs in clearcuts can be attributed to the presence of palatable species such as common snowberry, *(Symphoricarpos albus)* and spiraea (Table 2).

TABLE 5. A SUMMARY OF THE RESULTS OF KIRSCH'S (1962) FOOD HABITS STUDY OF ELK OF THE LITTLE BELT MOUNTAINS.

	Percent of Various Forage Classes in Diet						Usage Value of Preferred Forb Species Expressed as Percent of Total Forage used in Summer	
	SUMMER June - August			EARLY FALL September				
	Grass	Forb	Shrub	Grass	Forb	Shrub	Percent	Species
Little Belt Range	6	86	7				40	*Taraxacum* spp.
Deadhorse Sale Clearcuts	9	65	26	39	53	4	52	*Aster* spp., *Epilobium* spp., *Arnica cordifolia*
Adjacent Parks	12	79	9	97	2	–	50	*Taraxacum* spp. *Agoseris glauca*, *Geranium* spp., *Potentilla* spp.

TABLE 6. CANOPY COVERAGES, FREQUENCIES, AND MOST ABUNDANT FORB FORAGE SPECIES AS DETERMINED BY EXAMINATION OF FORTY 2 X 5 DECIMETER PLOTS IN EACH OF THE FOUR MOST USED BLOCKS.

Clearcut	Age	Canopy Coverage/Frequency Grass	Forbs	Shrubs	Most Abundant Forb
A	7-8	7/40	28/95	9/65	*Epilobium angustifolium*
B	2-3	4/30	41/98	12/68	*Arnica cordifolia*
C	8-9	19/73	29/100	20/80	*Aster* sp.
D	7-8	28/78	21/95	10/63	*Lupinus*

Months of use of two "ice cream" forb species could explain some of the attractiveness of Clearcuts A and D (Tables 4, 5, and 6). The majority of elk using A were observed during July and August, when the phenology of fireweed was conducive to heavy use by elk. I noted wide patches of this tall forb, 2-3 feet in height, clipped to the soil surface by feeding elk during these months. Eighty-four percent of the elk observed in D were using this block from mid-August to the end of September, a time when silvery lupine was still succulent. Kirsch (1962) attributed heavy forb usage in clearcuts during September to this plant. The forage class of grasses was becoming more important in the diet in late August and September, and the high coverage of this class in Clearcut D probably accounted for some of the increased use of this block during these months.

Cleanliness of Clearcut

Coop (1971) recorded only three instances of use, totaling 20 elk, for 470 acres of clearcuts located at the head of Harrison Creek (Figure 1). Some of these were five to six years old but none had been cleared of slash or burned before late fall of 1970. I made numerous observational trips, both ground and air, to three clearcuts at the head of Lions Creek and observed no elk (Figure 1). These cuts ranged in age from 3-6 years over the two summers of study, and 36-78 acres in size. All were heavily laden with logging debris; none had been slash-piled or burned (Figure 5). Both the Harrison Creek and

Lions Creek clearcut areas were in the immediate vicinity of summer habitat used by large numbers of elk, and observations of groups of 20 to 40 elk were made within one mile of these clearcuts.

Two clearcuts at the head of Whitetail Creek, seven and nine years of age during the first summer of study, were in close proximity to Clearcuts A and B, which were rated as receiving the most elk use on my intensive study area (Table 4). The seven year old cut was located about 200 yards east of A, and the nine year old cut lay between A and B (Figure 2). Neither of these two cuts had been cleared of logging debris, although a broadcast burn was attempted in the fall of 1971 in the seven year old cut, and a similar burn had taken place during a previous year in the nine year old cut. These two cuts and Clearcut A were clearly observed from the same area and therefore an equal amount of time was spent observing each. A total of 14 elk was observed in the unclean cuts and only four of these were in the one with the greatest amount of debris, while 1,034 elk were recorded as using Clearcut A. Elk observed in A were frequently using the middle of the cut, 200 yards from escape cover, while the few elk observed in the unclean cuts lingered on the edges.

Use by Elk of Openings of Varying Sizes and Amounts of Edge

For this analysis open areas, which included total acreages of clearcuts and adjoining natural parks and burns, were grouped according

to size into one or the other of three categories (Figure 9). The smallest opening was seven acres while the largest was 153 acres. Values for elk observed/acre (Figure 9a) and for both current and previous years pellet groups/acre (Figure 9b) indicated elk used openings larger than 80 acres more extensively than smaller open areas. The data for elk observed/acre and current pellet groups/acre show a positive relation between sizes of openings and use by elk. All four of the most used clearcuts were greater than 40 acres in size and two were greater than 80 acres (Table 4). After adding adjacent open area acreages, three were included in the greater than 80 acre size category (Figure 9). Most of the clearcuts in the less than 40 acre size category were located on the north and east faces of Green Mountain (Figure 2), an area receiving less elk use during the summer than the area to the south, and almost all of them were greater than 10 years of age. These factors possibly exerted a greater influence on use by elk than did size.

Kirsch (1962) evaluated blocks ranging in size from 5.1 to 55 acres in this area. Seventy-four percent of all elk groups used blocks in the 15.2 to 25.2 acre size class which comprised 57 percent of all clearcuts. Use of 20 blocks ranging in size from 6-88 acres in the Russian Creek Sale was analyzed by Coop (1971). The three most used averaged 30.66 acres in size. The blocks considered by both Kirsch and Coop averaged much smaller than the blocks in my study.

a.) Elk observed/acre/year

Size Group - Acres	0-40	40-80	80+
Range	14-39	43-78	88-153
No. of Open Areas	19	7	5
Total Acreage Examined	376	422	585
No. Elk Observed	60	359	1,430

b.) Pellet Groups/Acre

Size Group - Acres	0-40	40-80	80+
No. Plots Examined	300	180	230

■ Current Year
□ Previous Years

Figure 9. Use of each of three size classes of openings as indicated by elk observed/acre/year and pellet groups/acre.

The importance of "edge" to game species has long been recognized. Studies in Arizona by Reynolds (1962, 1966) and in Oregon by Harper (1966, 1971) have shown that use of an open area generally decreases as the distance from timber edge increases. Thus the shape of the clearcuts would influence the amount of edge and hence, the amount of use by elk within broad limits for a given size class. Clearcut C of the most used clearcuts (Table 4 and Figure 2) was characterized by a 12 acre strip of uncut timber in its center. Two of the others, A and B, were somewhat irregular in shape.

Cutting blocks adjacent to those previously cut lessens the proportion of edge to area logged. The Green Mountain Thinning Study Area (Figures 2 and 6) is a 251 acre cutover area consisting of 14 cuts of varying ages adjacent to each other. No elk were seen here. Pellet group counts made in each of two 2-year old cuts of this opening resulted in extremely low average counts of one and five per acre for current and previous years deposition, respectively. This low usage by elk could possibly reflect location as this large opening adjoined Spring Creek Road (Figure 2). Additional logging in subsequent years adjacent to the opening, seven acres of clearcut and seven acres of meadow (Figure 7), where Kirsch (1962) observed the most elk groups has created a 153 acre opening of eight different blocks and two natural parks. I observed eight groups totaling 34 elk in this opening which was less than two percent of the elk I saw using openings in my

intensive study area.

Minor Factors; Slope, Elevation, Aspect, and Moisture Condition of Clearcuts

Forest Service records categorize slopes by number: classes of 1, less than 16; 2, 16-25; 3, 26-35; and 4, 36-45 percent were represented in the blocks studied. The four most used blocks, A, B, C, and D had slopes of class 4, 2, 2, and 1, respectively. I could attribute no differences in elk use related to slope.

Elevations ranged from 6,300 to 7,000 feet in the 40 blocks in my intensive study area. Differences in elevation were not great enough to produce a pronounced variation in summer elk use. Cuts A, B, C. and D had elevations of 6,600, 6,500, 6,500, and 6,700 feet, respectively. Two blocks at 6,300 feet that were in the path of elk migrating to higher summer range received use during mid-June and none later.

Kirsch (1962) associated elk usage of clearcuts in summer with mesic and deer usage with xeric conditions. The block in which he observed the most elk usage was bissected by a mesic drainage (Figure 7). During this study, elk did not avoid blocks of xeric condition as both B and C were of this type, although water courses ran within a mile of their boundaries. Blocks A and D had active drainages within their edges.

There was a noticeable shift of elk from blocks of more southerly aspects to those of more northerly aspects from late spring to fall. This was partly due to dessication of vegetation, particularly forbs, on the southern slopes. This seasonal shift influenced the numbers of elk observed in the four most used blocks (Table 4). More elk used blocks C, B, and A during late spring and summer than during early fall and a reversal of this trend occurred in block D (Figure 2). Similar movements have been reported by other investigators including Coop (1971), Picton (1960), Harper (1971), and Knight (1970).

Multiple Regression Analysis

The relations of the various factors which were studied that could have influenced the amount of elk use a clearcut received were tested by four separate multiple regression analyses. The dependent variable for each analysis as determined by the amount of recorded elk use of a clearcut was (Y_1) total elk observed; (Y_2) elk observed/acre; (Y_3) percent of observations during which elk were seen; and (Y_4) pellet groups of current years/acre. The independent variables were as follows: (X_1) distance from Spring Creek Road; (X_2) distance from the unbroken timber cover area; (X_3) age; (X_4) amount of logging debris; (X_5) size of opening; (X_6) moisture condition; (X_7) slope; (X_8) elevation; (X_9) aspect; and (X_{10}) size of cut. Analyses were completed by using a Statistical Laboratory Multiple Regression Program with the aid of Montana State University's XDS Sigma-7 computer. Partial

correlation coefficient values for the relationships between the measures of the amount of elk use and all independent variables are listed in Appendix Table 17.

The regression using the dependent variable (Y_4) was less likely to be subject to observational bias and was selected as the one that best explained the amount of elk use a cut received. The independent variables accounted for 64 percent of the variation of Y_4. Further analysis indicated that four of the independent variables; X_1, X_2, X_3, and X_4 accounted for 57 percent of the variation (Table 7); the other variables were of little significance and accounted for the remainder. As a result, the following equation was selected to provide the best estimate of the amount of elk use a cut received in relation to the four most significant variables: $Y_4 = 74.70 + 26.6X_1 - 12.2X_2 - 2.8X_3 - 21.4X_4$. This analysis shows that the amount of elk use as measured by current pellet groups per acre was greater when the clearcut had less logging debris, was of younger age, and further from Spring Creek Road but closer to unbroken timber cover.

Summary of Factors Influencing Use by Elk of Clearcuts

Quantitative and qualitative observations lead to the conclusion that only clearcuts created on or in close proximity to traditional elk summer range received appreciable use during the summers of my observations. Intensity of use of clearcuts so located was influenced

TABLE 7. PARTIAL CORRELATION COEFFICIENT VALUES AND CORRESPONDING PROBABILITY LEVEL VALUES FOR THE RELATIONSHIP BETWEEN CURRENTLY DEPOSITED PELLET GROUPS/ACRE, (Y_4) AND FOUR VARIABLES INFLUENCING ELK USE OF CLEARCUTS, (X_1 - X_4).

Dependent Variable	Independent Variables							
	X_1		X_2		X_3		X_4	
Y_4	rc	P value	rc	P value	rc	P value	rc	P value
	.380*	.074	-.240	.274	-.520*	.012	-.612*	.002

rc = Calculated partial correlation coefficient.

P value = Probability of a partial correlation coefficient as large as that observed when the true partial correlation is zero.

Correlation coefficient of significance (Snedecor and Cochran 1971) = .317 (*Significant at the .05 probability level).

Y_4 = Pellet groups of current years per acre.

X_1 = Shortest distance from the center of a clearcut to Spring Creek Road; the area of greatest human disturbance (tenths of miles).

X_2 = Shortest distance from nearest edge of a clearcut to a theoretical line drawn along the edge of the unbroken timber cover area (tenths of miles).

X_3 = Age of clearcut at time of sampling (years).

X_4 = Amount of logging debris present (1, clean; 2, intermediate; 3, unclean).

by age and hence quantity of suitable forage present, their location in relation to areas of human disturbance and extensive timber cover, post treatment of slash resulting from logging operations, and possibly by size of opening, and the amount of edge in relation to the size of opening. Clearcuts of younger ages (2-10 years), in areas of minimum human disturbance, adjacent to extensive blocks of timber, and cleared of logging slash were best suited for use by elk. Intensity of elk use was greater in openings larger than 80 acres in size, but most clearcuts of smaller sizes were of less attractive locations and ages. Multiple regression analysis using current pellet groups/acre as the dependent variable verified the lesser significance of the size of opening factor. Although the other four factors appeared important, some were more critical than others and functioned in the sense of limiting factors regardless of the influence of other factors. Location of the clear-cut appeared most often to assume the role of the limiting factor.

Use of Clearcuts by Deer and Cattle

Counts of pellet groups within 1/100 acre plots generally indicated that the intensity of deer use increased as clearcuts aged, and intensity of cattle use decreased (Table 8). They also indicated that deer used openings of less than 40 acres and cattle used openings greater than 80 acres in size more extensively than other size classes (Table 9). Cuts of the smaller class of openings, averaging 13.9

TABLE 8. USE OF EACH OF FOUR AGE GROUPS OF CLEARCUTS BY DEER AND CATTLE AS INDICATED BY PELLET GROUPS/ACRE DEPOSITED DURING CURRENT AND PREVIOUS YEARS.

Age Group of Clearcuts (Yrs.)	2-4	7-10	11-15	16-20
Number of Cuts Examined	4	6	9	6
Number of Plots Examined	140	180	200	190
Intensity of Deer Use	3/66[1]	3/42	4/105	11/113
Intensity of Cattle Use	28/57	0/20	2/16	0/2

[1]Three pellet groups/acre deposited during year of examination/66 pellet groups/acre deposited during years previous examination.

TABLE 9. USE OF EACH OF THREE SIZE CLASSES OF OPENINGS BY DEER AND CATTLE AS INDICATED BY PELLET GROUPS/ACRE DEPOSITED DURING CURRENT AND PREVIOUS YEARS.

Size Class of Openings in Acres	Less than 40	40-80	Greater than 80
Range in Acres	14-39	43-78	88-153
Number of Openings Examined	12	5	5
Number of Cuts Examined	12	7	6
Average Age of Cuts	13.9	9.3	7.5
Number of Plots Examined	300	180	230
Intensity of Deer Use	8/112[1]	2/36	4/82
Intensity of Cattle Use	1/10	0/16	13/44

[1]Eight pellet groups/acre deposited during year of examination/112 pellet groups/acre deposited during years previous to examination.

years of age, were older and cuts of the larger class, averaging 7.5 years of age, were younger, and therefore contained more browse and grass, respectively (Figure 3).

Two species of deer were present on the study area (Figure 1). Whitetail deer *(Odocoileus virginianus)* were distributed in a small area of the Deadhorse Sale Area centered along the north face of Green Mountain (Figure 2). Mule deer *(Odocoileus hemionus)* were evenly

distributed throughout the entire study area. Both species of deer were less selective than elk in use of clearcuts with reference to location in relation to man's disturbances and areas of extensive unbroken cover. They used all cuts in all Sale Areas located within their summer ranges. Mule deer did appear to prefer cuts that were heavily laden with slash, and those cuts avoided by elk at the head of Lion Creek were heavily used by deer. Studies by Reynolds (1962, 1966) and Pearson (1968) have shown deer use to decrease following cleanup of slash.

Cattle generally used all clearcuts that were of lesser slope and cleaned of slash and, therefore, more easily accessible. Cattle did use the four cuts most extensively used by elk (Figure 2). Ten or more head of cattle used each of these cuts throughout the summer and early fall seasons.

Population Structure

All observations of elk recorded during ground and aerial observations were classified as to sex and age (Table 10). The cow:bull ratio was 100:21; 63 percent of all males observed were spikes which reflected the type of hunting allowed. General hunting was for antlered bulls, and cows could legally be harvested by special permit holders only. The cow:calf ratio was highest in August; this value being 100:53 for both years combined. Coop's (1971) highest cow:calf

TABLE 10. CLASSIFICATION BY SEX AND AGE OF ELK OBSERVED DURING THE PERIODS JUNE 16-SEPTEMBER 19, 1971 AND JUNE 8-NOVEMBER 26, 1972 (INCLUDES DUPLICATE OBSERVATIONS OF THE SAME INDIVIDUALS).

Cows	Calves	Males		Unclassified	Total Elk	Total Groups
		Yearlings	Older			
1,347	550	179	105	1,553	3,734	444

ratio; 100:57, for this area was during July. Records compiled for an unlisted number of years indicate the average cow:calf ratio in the Little Belts to be 100:54 and to range from 100:51 - 58 (Rognrud and Janson 1971). Average group sizes by two week intervals ranged from 3.5 for early June to 17.5 for early August (Appendix Table 18). The largest group of elk observed, 95, was using Clearcut A (Figure 2) on the evening of July 15, 1971. Kirsch (1962) in the Little Belts and Picton (1960) in the Sun River area observed summering groups of elk as large as 56 and 119, respectively.

Movements and Distribution of Elk

Elk from each of three winter ranges; Judith, Spring Creek-Round Grove, and Haymaker, used the area of my study during summer (Figure 10). Estimates of the number of elk wintering in these areas are 1,000, 200, and 200, respectively. Kirsch (1962) and Coop (1971) described the movements and distributions of the Judith segment. Emphasis of my study was to record similar information about the other

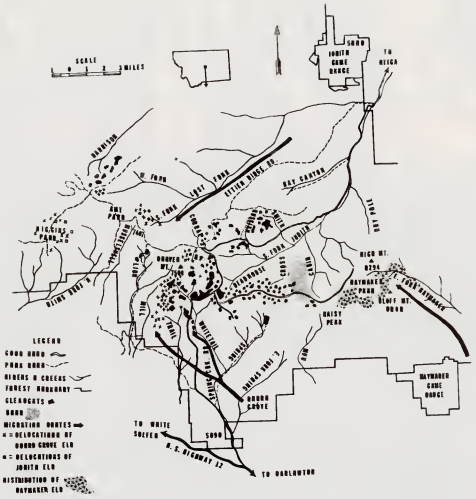


Figure 10. Map of study area indicating movements of three herd segments of elk from winter to summer range and distributions of each on summer range.

two segments, each of which winters on the south-facing slopes.

Since the spring of 1970, thirty-three individual elk have been marked in the Spring Creek-Round Grove wintering area (Figure 10). Only five were marked during 1970, and one of these was rebanded during the winter of 1972, along with 28 additional individuals. Not all of the marked individuals were available for relocation observations, since a few were observed with eartags and no band indicating a loss of the latter. One was killed in this condition, and one "lost" was found shortly after having been put on. Four elk marked during previous winters on the Judith Game Range wintered in this area during 1971-72. Eighteen of the 37 marked elk were relocated at least once and as often as 10 times for a total of 71 relocations.

Elk from the Spring Creek-Round Grove wintering area appeared to move in a westerly direction during early spring and then in a northerly direction to higher summer range as topography and snow conditions dictated. Locations of marked elk suggested that most of these elk traveled along one or the other of two main routes to the clearcut area west of Spring Creek Road; one route was located between Trail and Mill Creeks and the other was located along Whitetail Creek, a tributary stream to Spring Creek (Figure 10). Some of these elk appeared to remain in this clearcut area while others traveled to one or both of two other areas; the heads of the Musselshell and South Fork of the Lost Fork area, and the Higgins Park area, which served as

centers of activity for elk during the summer and pre-hunting season fall periods. These areas were shared with elk from the Judith segment. Relocations of individuals indicated that elk did not necessarily remain in any one of these three areas, but traveled back and forth between them (Table 11). A yearling male traveled from the

TABLE 11. MOVEMENTS OF MARKED ELK BETWEEN SUMMER CENTER OF ACTIVITY AREAS DURING 1972.

Elk Sex and Age	Dates of Observation at Center of Activity Area: Clearcut Area West of Spring Creek Road	Head of South Fork of Lost Fork Area	Higgins Park Area
♀ Yrlg	7/18		8/10
♂ Yrlg	7/25, 8/7, 10/22	8/10	7/26
♀ Yrlg	6/21		7/26
♀ Mature	4/15, 7/13	6/19, 7/8	7/27
♀ 2	6/11		7/8

clearcut area to the Higgins Park area, a distance of eight air miles, in 24 hours or less, and returned a week later. When hunting season began, many of the elk in the clearcut area moved east of Spring Creek Road and concentrated activities near and within the Cross Creek Burn area (Figure 10). As hunters discovered their whereabouts and applied pressure and as snow conditions became more severe, these elk moved down Spring Creek toward the winter range. Elk located at the other two centers of activity moved to lower elevations of heavier timbered areas which were less accessible to hunters. Evidently a few traveled

down drainages to the north, as at least two marked on the south side wintered on the Judith during 1972-1973.

No elk from the Haymaker segment were marked. Observations of many unmarked elk and the absence of any observations of marked elk in the Haymaker Park area, a summer center of activity, indicated this to be the summer range for this segment. Elk of the Haymaker segment appeared to migrate upwards along the bottom of the steep-walled East Fork of Haymaker Canyon. They were distributed at the head of this canyon and throughout the Haymaker Park-High Mountain area during the summer and early fall periods. By the time hunting season had begun most had moved back down Haymaker Canyon and were entirely removed from heavy hunter pressure as this canyon was extremely inaccessible to man. Visual representation of this segments distribution is shown in Figure 10.

In addition to the movements described, local residents are of the opinion that there is an exchange of elk between the south side of the Little Belts and the Castle Mountains to the north. A paved highway separates the two ranges. Other than that no extreme geographical barriers exist.

Use of the Study Area by Cattle

Cattle allotment boundaries are illustrated on Figure 11 along with corresponding numbers of cattle, excluding calves, and animal

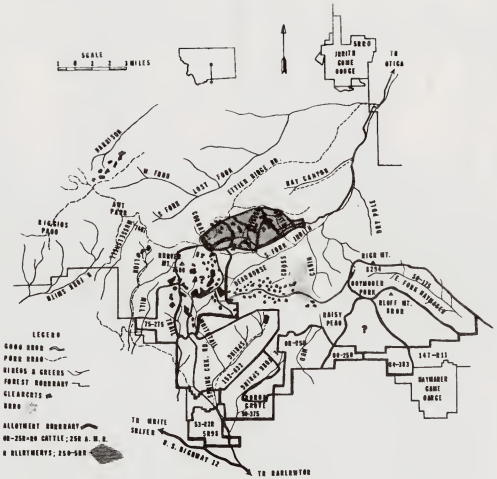


Figure 11. Map of study area indicating cattle allotment boundaries and number of cattle and animal month units allowed on each during the grazing season of 1972.

month units allowed in each allotment during the grazing season of 1972. Data are unlisted for two of the allotments and combined for eight allotments located in the Russian Sale Area. Nineteen allotments were present on the study area, but more were allowed in the Little Belt range. Use of allotments ranged from 1.5 to 4.2 months.

No quantitative measurements were made which would indicate degree of competition between cattle and elk. In general, cattle used easily accessible areas located in drainage bottoms and along roads. They were not present on some areas heavily used by elk during the summer. However, casual observation of areas used by both revealed that competition on the higher summer range probably existed in a few areas; Haymaker Park, the four most used clearcuts west of Spring Creek Road (Figure 2), and the most used clearcuts in the Russian Creek Sale Area. Ot these three areas, the most serious competition appeared to occur in the Haymaker Park area.

The most serious problem created by cattle use of the study area was on the lower foothill areas of the south slopes, upon which cattle summer and elk winter. By the early fall season, months before elk have made use of these low areas, these slopes appeared barren of most palatable vegetation. This problem was most severe on those allotments located on the two major winter concentration areas ot elk; the Spring Creek-Round Grove area and along the boundaries of the Haymaker Game Range (Figure 11). Stevens (1966) described a similar situation

occurring on another elk winter range in Montana.

APPENDIX

TABLE 12. PERCENT CANOPY COVERAGE, FREQUENCY, AND CONSTANCY OF LOW-GROWING TAXA IN CLEARCUTS 2, 3, AND 4 YEARS AFTER CUTTING AND COMBINED TOTAL FOR THE AGE GROUP, 2-4 YEARS, AS DETERMINED BY EXAMINATION OF TWENTY OR FORTY, 2 X 5 DECIMETER PLOTS AT EACH CLEARCUT EXAMINED.

No. of Clearcuts	3	1	2	6
No. of Plots	100	20	80	200
Age of Clearcuts	2	3	4	2-4
Taxa[1]				
Grasses	9/50/100[2]	4/40	6/44/100	7/47/100[3]
Agropyron spp., *spicatum, repens*	.8/3/67	--	--	tr/2/33
Agrostis scabra	2/16/33	--	tr/5/50	1/10/67
Festuca spp., *idahoensis, scabrella*	1/5/33	--	3/15/100	2/9/67
Poa spp.	3/8/67	--	--	2/4/33
Stipa spp., *columbianum*	tr[4]/2/33	--	.8/3/50	tr/2/67
Trisetum spicatum	1/3/67	4/25	tr/1/50	.8/5/100
Unidentified Grasses	1/15/100	tr/15	2/19/100	1/17/100
Forbs	32/83/100	25/95	38/99/100	37/91/100
Achillea millefolium	tr/8/67	--	tr/5/50	tr/6/67
Antennaria spp., *racemosa, rosea, parvifolia*	--	tr/5	.5/8/50	tr/4/67
Arnica cordifolia	7/33/100	--	7/51/100	6/37/67
Aster spp., *foliaceus*	6/23/100	5/35	11/54/100	8/37/100
Astragalus spp., *miser*	3/11/33	5/45	6/20/50	4/18/100
Cirsium spp., *arvense, undulatum, canovirens*	.5/4/67	tr/10	4/33/100	2/16/100
Epilobium angustifolium	tr/5/67	tr/5	tr/5/100	tr/5/100
Galium boreale	3/20/67	2/25	3/36/100	3/27/100
Geranium spp., *viscosissimum, richardsonii*	3/16/100	6/55	.8/6/100	2/16/100
Hedysarum sulphurescens	tr/1/33	--	1/8/50	.5/4/67
Hieracium albiflorum	.6/8/67	--	--	tr/4/33
Lupinus spp., *argenteus*	4/23/67	tr/10	--	2/13/67
Lycopus asper	tr/1/33	5/25	--	.7/3/67
Osmorhiza depauperate	--	--	tr/5/50	tr/2/33
Penstemon rydbergii	2/8/33	--	tr/6/100	1/7/67
Potentilla spp., *gracilis, arguta*	1/7/33	--	tr/1/50	.6/4/67

TABLE 12. Continued.

No. of Clearcuts	3	1	2	6
No. of Plots	100	20	80	200
Age of Clearcuts	2	3	4	2-4
Taxa				
Forbs (Continued)				
Senecio spp., *canus*	--	--	.8/11/100	tr/5/33
Taraxacum officinale	.7/8/67	1/15	2/28/100	1/17/100
Thalictrum venulosum	.5/7/33	--	8/20/100	3/12/67
Unidentified Forbs	tr/4/67	tr/5	.5/3/100	tr/4/100
Shrubs	17/77/100	21/90	31/83/100	23/81/100
Arctostaphylos uva-ursi	1/3/67	--	--	.6/2/33
Berberis repens	1/12/67	2/35	6/44/100	3/27/100
Fragaria spp., *virginiana*	3/29/100	4/25	8/44/100	5/35/100
Juniperus spp., *communis*	tr/1/33	--	.5/4/100	tr/2/67
Linnaea borealis	tr/2/33	tr/5	--	tr/2/67
Rosa spp.	3/20/100	5/15	1/13/100	3/17/100
Spiraea spp.	6/49/100	10/70	10/51/100	8/52/100
Symphoricarpus albus	--	tr/10	5/33/100	2/14/67
Vaccinium scoparium	1/17/67	--	--	.6/9/33
Unidentified Shrubs	--	tr/10	--	tr/1/33
Sedges				
Carex spp., *geyeri*	12/48/100	7/10	8/44/100	10/41/100
Bare Ground	15/35/100	5/70	11/31/100	14/37/100
Rock	--	--	--	--
Litter	83/100/100	73/100	87/100/100	83/100/100

[1]Includes those taxa with a canopy coverage of .5 percent or greater or a frequency of 5 percent or greater in at least one age of clearcut. Others are listed in Appendix Table 16.

[2]Canopy coverage (percent of area covered)/average frequency (percent occurrence among plots)/constancy (percent occurrence among clearcuts of that year of age).

[3]Canopy coverage/average frequency/constancy (percent occurrence among clearcuts of different ages).

[4]tr = Trace; a value less than .5 percent.

TABLE 13. PERCENT CANOPY COVERAGE, FREQUENCY, AND CONSTANCY OF LOW-GROWING TAXA IN CLEARCUTS 7, 8, 9, AND 10 YEARS AFTER CUTTING AND COMBINED TOTALS FOR THE AGE GROUP, 7-10 YEARS, AS DETERMINED BY EXAMINATION OF TWENTY OR FORTY, 2 X 5 DECIMETER PLOTS AT EACH CLEARCUT EXAMINED.

No. of Clearcuts No. of Plots Age of Clearcuts	1 40 7	3 100 8	1 20 9	1 20 10	6 180 7-10
Taxa[1]					
Grasses	6/40	20/76/100[2]	16/60	13/80	16/67/100[3]
Agropyron spp., *epicatum, repens*	.6/10	3/11/67	12/40	--	3/13/75
Agrostis scabra	tr[4]/3	2/4/67	--	--	1/3/50
Bromus spp., *marginatus, inermis*	3/10	2/12/67	.3/10	.3/10	2/11/100
Festuca spp., *idahoensis, scabrella*	tr/3	3/15/33	4/25	--	2/12/75
Phleum spp., *pratensis, alpinum*	--	2/6/67	--	--	1/3/25
Poa spp.	--	2/12/67	--	--	.8/7/25
Trisetum spicatum	--	4/26/100	--	11/50	3/20/50
Unidentified Grasses	2/13	2/13/33	tr/5	2/5	2/11/100
Forbs	31/95	34/97	34/100	48/95	35/97/100
Achillea millefolium	tr/3	1/15/100	.9/10	2/20	.9/12/100
Agroseris spp., *glauca, aurantica*	--	--	--	tr/5	tr/tr/25
Allium spp., *brevistylum, textile*	--	tr/3/33	--	.9/10	tr/3/50
Antennaria spp., *racemosa, rosea, parvifolia*	--	2/25/100	8/55	tr/5	2/21/75
Arnica cordifolia	3/33	.7/18/100	1/50	2/30	1/26/100
Aster spp., *foliaceus*	5/23	8/51/100	10/55	12/80	8/48/100
Astragalus spp., *miser*	2/10	.7/8/67	tr/5	.8/5	.9/8/100
Campanula rotundifolia	--	tr/1/33	2/15	--	tr/2/50
Cirsium spp., *arvense, undulatum, canovirens*	4/18	4/30/100	1/20	--	3/23/75
Dodecatheon conjugens	--	--	--	2/15	tr/2/25
Epilobium angustifolium	6/35	2/17/67	4/30	2/10	3/22/100

TABLE 13. Continued.

No. of Clearcuts	1	3	1	1	6
No. of Plots	40	100	20	20	180
Age of Clearcuts	7	8	9	10	7–10
Taxa					
Forbs (Continued)					
Epilobium paniculatum	—	—	—	.6/25	tr/3/25
Galium boreale	3/25	.9/12/33	3/35	2/20	2/18/100
Geranium spp., *viscosissimum, richardsonii*	.8/8	1/10/100	2/10	3/10	1/9/100
Heuchera cylindrica	—	tr/1/33	tr/5	—	tr/1/50
Hieracium albiflorum	—	.6/13/67	—	tr/15	tr/9/50
Lomatium triternatum	—	—	—	tr/5	tr/tr/25
Lupinus spp., *argenteus*	tr/3	3/23/100	tr/10	.9/10	2/16/100
Mertensia spp., *oblongifolia*	1/10	1/8/33	tr/5	—	.9/7/75
Penstemon rydbergii	—	.8/5/33	tr/5	tr/5	tr/4/75
Potentilla spp., *gracilis, arguta, ovina*	—	tr/1/33	—	2/15	tr/2/50
Senecio spp., *canus*	—	tr/1/33	—	2/15	tr/2/50
Taraxacum officinale	4/30	3/36/100	3/40	1/20	3/33/100
Thalictrum venulosum	tr/8	.9/5/33	—	2/20	.7/7/75
Tragopogon dubius	—	—	—	tr/5	tr/tr/25
Trifolium spp.	—	tr/1/33	—	14/25	2/3/50
Unidentified Forbs	tr/3	.7/7/100	—	—	tr/4/50
Shrubs	10/65	17/73	31/90	17/85	17/74/100
Berberis repens	3/30	4/21/67	6/30	.9/10	3/23/100
Fragaria virginiana	4/25	5/42/100	20/60	5/45	7/41/100
Rosa spp.	1/10	2/12/100	3/30	2/20	2/14/100
Rubus idaeus	—	—	.8/5	—	tr/tr/25
Spiraea spp.	2/28	2/23/100	1/15	3/25	2/23/100
Vaccinium membranaceum	—	1/14/67	—	1/15	.8/9/50

TABLE 13. Continued.

No. of Clearcuts	1	3	1	1	6
No. of Plots	40	100	20	20	180
Age of Clearcuts	7	8	9	10	7-10
Taxa					
Shrubs (Continued)					
Vaccinium scoparium	--	2/15/67	--	5/35	2/12/50
Sedges					
Carex spp., *geyeri*	10/35	13/40/100	25/70	16/50	14/43/100
Bare Ground	11/55	20/56/100	2/35	7/30	14/51/100
Rock	tr/7	tr/2/33	--	--	tr/3/50
Litter	84/100	77/100/100	93/100	89/100	82/100/100

[1]Includes those taxa with a canopy coverage of .5 percent or greater or a frequency of 5 percent or greater in at least one age of clearcut. Others are listed in Appendix Table 16.

[2]Canopy coverage (percent of area covered)/average frequency (percent occurrence among plots)/ constancy (percent occurrence among clearcuts of that year of age).

[3]Canopy coverage/average frequency/constancy (percent occurrence among clearcuts of different ages).

[4]tr = Trace; a value less than .5 percent.

TABLE 14. PERCENT CANOPY COVERAGE, FREQUENCY, AND CONSTANCY OF LOW-GROWING TAXA IN CLEARCUTS 11, 12, 13, 14, AND 15 YEARS AFTER CUTTING AND COMBINED TOTALS FOR THE AGE GROUP, 11-15 YEARS, AS DETERMINED BY EXAMINATION OF TWENTY OR FORTY, 2 X 5 DECIMETER PLOTS AT EACH CLEARCUT EXAMINED.

No. of Clearcuts	4	2	1	1	1	9
No. of Plots	80	40	40	20	20	200
Age of Clearcuts	11	12	13	14	15	11-15
Taxa[1]						
Grasses	12/69/100[2]	7/66/100	7/65	24/75	6/75	10/69/100[3]
Agropyron spp., *spicatum, repens*	2/13/25	--	--	19/40	--	3/9/40
Agrostis scabra	1/10/50	--	1/15	--	--	.6/7/40
Bromus spp., *marginatus, inermis*	tr[4]/1/25	tr/3/50	tr/3	--	.8/5	tr/2/80
Festuca spp., *idahoensis, scabrella*	4/18/25	3/25/100	tr/3	2/10	2/20	3/16/100
Hordeum jubatum	--	--	2/20	--	--	tr/4/20
Koelaria cristata	--	.9/3/50	--	--	--	tr/tr/20
Phleum alpinum	--	--	.9/3	--	--	tr/tr/20
Poa spp., *pratensis*	.8/5/50	tr/3/50	--	--	--	tr/2/40
Sitanion hystrix	--	tr/5/50	--	--	--	tr/1/20
Trisetum spicatum	2/19/75	--	2/28	2/15	3/40	2/19/80
Unidentified Grass	1/16/75	2/40/100	1/18	2/10	1/10	1/20/100
Forbs	37/96/100	30/90/100	37/98	31/95	19/95	33/95/100
Achillea millefolium	1/18/75	.6/13/100	.6/13	tr/5	--	./13/80
Antennaria spp., *racemosa, rosea, parvifolia*	2/20/75	1/25/100	3/23	.9/10	5/55	2/24/100
Arabis divaricarpa	--	--	.5/8	--	--	tr/2/20
Arnica cordifolia	2/31/75	2/25/50	1/28	.8/3	tr/15	2/28/100
Aster spp., *foliaceus*	10/54/100	7/43/100	7/53	18/85	3/30	9/52/100
Astragalus spp., *miser*	2/13/25	1/5/50	2/15	2/15	--	1/10/80

TABLE 14. Continued.

No. of Clearcuts	4	2	1	1	1	9
No. of Plots	80	40	40	20	20	200
Age of Clearcuts	11	12	13	14	15	11-15
Taxa						
Forbs (Continued)						
Campanula rotundifolia	--	tr/5/100	1/13	tr/15	--	tr/5/60
Castilleja spp., *linariaefolia, cusickii*	--	--	--	2/20	--	tr/2/20
Cirsium spp., *arvense, undulatum, canovirens*	--	--	tr/5	--	--	tr/1/20
Collomia linearis	--	--	2/28	--	--	tr/6/20
Epilobium angustifolium	2/18/100	1/18/50	1/18	2/40	3/25	2/21/100
Galium boreale	1/23/50	--	--	--	--	tr/9/20
Geranium spp., *viscosissimum, richardsonii*	.7/15/50	.9/3/50	--	1/20	--	.6/9/60
Hedysarum sulphurescens	1/9/75	.9/10/50	.8/5	2/20	--	1/9/80
Helianthus nuttallii	--	tr/5/50	--	--	--	tr/1/20
Hieracium albiflorum	1/11/25	.7/15/100	2/45	--	5/55	1/22/80
Lupinus spp., *argenteus*	7/34/75	11/48/100	10/50	--	3/50	7/38/80
Penstemon rydbergii	tr/5/50	--	.4/5	tr/10	--	tr/4/60
Potentilla spp., *arguta*	.8/9/50	--	--	.8/5	--	tr/4/40
Taraxacum officinale	3/30/100	2/35/100	2/38	tr/15	--	2/28/80
Thalictrum venulosum	2/11/50	tr/3/50	--	--	--	1/5/40
Unidentified Forbs	tr/1/25	.7/15/50	tr/3	.9/10	--	tr/5/80
Shrubs	22/81/100	22/88/100	21/88	30/95	24/90	23/86/100
Berberis repens	3/28/75	--	1/13	3/25	.9/15	2/18/80
Ceanothus velutinus	--	.9/3/50	--	--	--	tr/tr/20
Fragaria spp.	4/21/25	4/25/100	3/18	10/60	--	4/23/80
Juniperus spp., *communis*	.8/4/25	1/8/50	tr/3	--	.8/5	.7/4/80
Linnaea borealis	--	--	--	tr/5	--	tr/tr/20

TABLE 14. Continued.

No. of Clearcuts	4	2	1	1	1	9
No. of Plots	80	40	40	20	20	200
Age of Clearcuts	11	12	13	14	15	11-15
Taxa						
Shrubs (Continued)						
Ribes spp., *cereum lacustre*	tr/1/25	.5/8/50	tr/3	--	--	tr/3/60
Rosa spp.	3/16/75	.8/8/50	2/18	1/10	.8/5	2/13/100
Salix spp.	--	--	--	.8/5	--	tr/tr/20
Spiraea spp.	6/48/100	7/53/100	5/65	3/45	8/65	6/54/100
Symphoricarpus albus	1/9/50	--	--	--	.8/5	.5/4/40
Vaccinium membranaceum	1/10/75	3/15/50	3/23	--	7/40	2/16/80
Vaccinium scoparium	3/23/75	4/25/100	6/38	10/45	6/30	5/29/100
Unidentified Shrubs	--	--	--	2/5	--	tr/tr/20
Sedges						
Carex spp., *geyeri*	18/64/100	16/58/100	9/60	7/30	6/35	13/56/100
Bare Ground	21/55/100	5/25/100	14/50	--	28/70	18/44/80
Rock	--	10/30/50	2/15	.8/5	2/10	3/21/80
Litter	76/100	81/100/100	84/100	96/100	71/100	80/100/100

[1]Includes those taxa with a canopy coverage of .5 percent or greater or a frequency of 5 percent or greater in at least one age of clearcut. Others are listed in Appendix Table 16.

[2]Canopy coverage (percent of area covered)/average frequency (percent occurrence among plots)/ constancy (percent occurrence among clearcuts of that year of age).

[3]Canopy coverage/average frequency/constancy (percent occurrence among clearcuts of different ages).

[4]tr = Trace; a value less than .5 percent.

TABLE 15. PERCENT CANOPY COVERAGE, FREQUENCY, AND CONSTANCY OF LOW-GROWING TAXA IN CLEARCUTS 16, 17, AND 20 YEARS AFTER CUTTING AND COMBINED TOTALS FOR THE AGE GROUP, 16, 17, AND 20 YEARS, AS DETERMINED BY EXAMINATION OF TWENTY, FORTY, OR FIFTY, 2 X 5 DECIMETER PLOTS AT EACH CLEARCUT EXAMINED.

No. of Clearcuts	2	4	1	7
No. of Plots	80	130	20	230
Age of Clearcuts	16	17	20	16,17,20
Taxa[1]				
Grasses	8/48/100[2]	5/40/100	6/55	7/44/100[3]
Agropyron spp.	tr[4]/1/50	--	--	tr/tr/50
Agrostis scabra	tr/8/50	.6/2/25	--	.5/4/50
Festuca spp., *idahoensis*	3/9/50	.9/7/50	2/5	2/9/100
Phleum spp., *alpinum*	1/2/100	--	--	tr/1/50
Trisetum spicatum	1/17/50	2/19/50	3/30	2/19/75
Unidentified Grasses	2/17/100	2/16/100	1/25	2/17/100
Forbs	27/94/100	19/79/100	34/100/100	24/87/100
Agoseris spp., *glauca, aurantica*	tr/1/50	tr/1/25	2/20	tr/3/75
Antennaria spp.	3/23/100	2/23/75	3/20	2/23/75
Arnica cordifolia	--	tr/8/75	3/40	tr///50
Aster spp., *foliaceus*	8/44/100	2/12/50	10/70	5/30/100
Astragalus spp., *miser*	.6/9/50	tr/1/25	--	tr/4/50
Campanula rotundifolia	.6/8/100	tr/1/25	tr/10	tr/4/75
Castilleja spp., *linariaefolia, cusickii*	--	tr/1/25	2/30	tr/3/50
Dodecatheon conjugens	--	--	.8/5	tr/tr/25
Epilobium angustifolium	5/44/100	6/53/100	5/40	5/48/100
Galium boreale	--	tr/2/25	--	tr/2/50
Geranium spp., *viscosissimum, richardsonii*	--	tr/2/25	3/20	tr/3/75
Hedysarum sulphurescens	2/13/100	--	.8/5	1/6/50
Hieracium albiflorum	1/33/100	.5/13/75	2/55	1/25/75
Lupinus spp., *argenteus*	6/38/100	8/38/100	.9/10	7/37/100
Potentilla spp.	--	--	tr/5	tr/tr/25
Taraxacum officinale	.8/9/100	tr/1/25	--	tr/6/75
Trifolium spp.	--	tr/2/25	2/10	tr/2/50
Unifentified Forbs	tr/3/100	tr/2/50	tr/5	tr/3/100

TABLE 15. Continued.

No. of Clearcuts	2	4	1	7
No. of Plots	80	130	20	230
Age of Clearcuts	16	17	20	16,17,20
Taxa				
Shrubs	35/93/100	36/87/100	23/100	34/95/100
Berberis repens	1/9/50	--	--	.6/3/25
Fragaria spp., *virginiana*	2/8/100	1/8/75	2/35	1/10/100
Juniperus spp., *communis*	4/8/50	.5/3/50	.8/5	2/5/75
Linnaea borealis	tr/1/50	2/10/75	--	1/6/50
Ribes spp., *viscosissimum*	tr/1/50	--	.8/5	tr/1/50
Rosa spp.	.9/8/50	tr/3/25	2/10	.6/5/100
Spiraea	6/58/100	4/33/100	7/65	5/43/75
Symphoricarpus albus	tr/1/50	.7/3/25	--	.5/2/50
Vaccinium membranaceum	7/42/100	3/17/50	9/55	5/30/100
Vaccinium scoparium	15/70/100	24/68/100	2/20	18/65/100
Sedges				
Carex spp., *geyeri*	22/71/100	7/36/100	8/50	13/51/100
Bare Ground	5/23/100	4/14/100	20/95	6/25/100
Rock	.4/7/50	5/25/75	--	3/15/67
Litter	92/100/100	90/100/100	79/100	89/100/100

[1]Includes those taxa with a canopy coverage of .5 percent or greater or a frequency of 5 percent or greater in at least one age of clearcut. Others are listed in Appendix Table 16.

[2]Canopy coverage (percent of area covered)/average frequency (percent occurrence among plots)/constancy (percent occurrence among clearcuts of that year of age).

[3]Canopy coverage/average frequency/constancy (percent occurrence among clearcuts of different ages).

[4]tr = Trace; a value less than .5 percent.

TABLE 16. TAXA WITH LESS THAN .5 PERCENT CANOPY COVERAGE AND/OR FREQUENCIES OF LESS THAN 5 PERCENT IN FOUR DIFFERENT AGE GROUPS OF CLEARCUTS AS DETERMINED BY EXAMINATION OF TWENTY, FORTY, OR FIFTY 2 X 5 DECIMETER PLOTS AT EACH CLEARCUT EXAMINED.

Age Group of Clearcuts	1-5			6-10				11-15					16,17,20		
Grasses	2	3	4	7	8	9	10	11	12	13	14	15	16	17	20
Bromus spp.	X[1]	-	X	0	0	0	0	0	0	0	-	0	X	-	-
Hordeum jubatum	-	-	-	-	X	-	-	-	-	0	-	-	-	X	-
Melica spectabilis	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
Phleum spp.	X	-	-	-	0	-	-	-	-	0	-	-	-	X	-
Poa spp.	0[2]	-	-	-	0	-	-	0	0	-	-	-	-	-	-
Forbs															
Achillea millefolium	0	-	0	0	0	0	0	0	0	0	0	-	X	X	-
Agoseris spp., *glauca, aurantica*	X	-	X	-	-	-	0	-	X	X	-	-	0	0	0
Anaphalis margaritacae	X	-	-	-	X	-	-	X	-	-	-	-	-	-	-
Arenaria congesta	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Balsamorhiza sagittata	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Campanula rotundifolia	X	-	X	-	0	0	-	-	0	0	0	-	0	0	0
Carduus nutans	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Castilleja spp., *linariaefolia, cusickii*	X	-	X	-	X	-	-	-	-	-	0	-	-	0	0
Collomia linearis	-	-	X	-	X	-	-	-	-	0	-	-	-	-	-
Crepis spp.	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dodecatheon conjugens	X	-	-	-	-	-	0	-	-	-	-	-	-	-	0
Douglasia montana	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Epilobium paniculatum	-	-	-	-	-	-	0	X	-	-	-	-	-	-	-
Erigonum flavum	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fraseria speciosus	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
Gaillardia aristata	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Hedysarum sulphurescens	0	-	0	-	X	-	-	0	0	0	0	-	0	-	0
Helianthus nuttallii	X	-	-	-	-	-	-	-	0	-	-	-	-	-	-

TABLE 16. Continued.

Age Group of Clearcuts	1-5			6-10				11-15					16,17,20		
Forbs (Continued)	2	3	4	7	8	9	10	11	12	13	14	15	16	17	20
Heuchera cylindrica	-	-	-	-	0	0	-	X	-	-	-	-	-	-	-
Iris missouriensis	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Lithospermum ruderale	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Mertensia oblongifolia	X	-	X	0	0	0	-	X	-	-	-	-	-	-	-
Osmorhiza depauperate	-	-	0	-	X	-	-	-	-	X	-	-	-	-	-
Pedicularis groenlandica	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Penstemon rydbergii	0	-	0	-	0	0	0	0	-	0	0	-	-	X	-
Ranunculus spp.	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
Senecio spp., *canus*	-	-	0	-	0	-	0	X	-	-	-	-	-	-	-
Smilacina stellata	-	-	X	X	-	-	-	X	-	-	-	-	-	-	-
Stellaria spp.	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Thlaspi arvense	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Tragopogon dubius	X	-	-	-	-	-	0	-	-	-	-	-	-	-	-
Trifolium	-	-	X	-	0	-	0	-	-	-	-	-	-	0	0
Urtica dioica	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Viola spp.	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Unidentified Compositae	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Shrubs															
Arctostaphylos uva-ursi	0	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Juniperus spp., *communis*	0	-	0	-	X	-	-	0	0	0	-	0	0	0	0
Ribes spp.	-	-	-	-	X	-	-	0	0	0	-	-	0	-	0
Rubus idaeus	-	-	-	-	-	0	-	-	-	-	-	-	-	X	-
Shepherdia canadensis	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Symphoricarpus albus	-	0	0	-	X	-	-	0	-	-	-	0	0	0	-
Vaccinium membranaceum	X	-	-	-	0	-	0	0	0	0	-	0	0	0	0
Unidentified Shrubs	-	0	-	X	-	-	-	-	-	-	0	-	-	-	-

TABLE 16. Continued.

Age Group of Clearcuts	1-5			6-10				11-15					16,17,20		
	2	3	4	7	8	9	10	11	12	13	14	15	16	17	20
Mushroom	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-

[1]X = Taxa with less than the requirements.

[2]0 = Taxa meeting the requirements; values listed in Appendix Tables 12, 13, 14, and 15.

TABLE 17. PARTIAL CORRELATION COEFFICIENT VALUES FOR THE RELATIONSHIPS BETWEEN EACH OF FOUR VALUES FOR AMOUNT OF ELK USE OF CLEARCUTS (DEPENDENT VARIABLES, Y_1 - Y_4) AND TEN VALUES FOR FACTORS WHICH WERE SUSPECTED OF INFLUENCING ELK USE (INDEPENDENT VARIABLES, X_1 - X_{10}).

Independent Variables	Dependent Variables							
	Y_1		Y_2		Y_3		Y_4	
	rc	rt	rc	rt	rc	rt	rc	rt
X_1	.396*	.339	.373*	.339	-.041	.344	.340	.344
X_2	-.074	.339	-.078	.339	-.339	.344	-.330	.344
X_3	-.229	.339	-.309	.339	-.160	.344	-.495*	.344
X_4	-.356*	.339	-.405*	.339	-.263	.344	-.573*	.344
X_5	.348*	.339	.255	.339	.176	.344	-.077	.344
X_6	-.235	.339	-.176	.339	.047	.344	.197	.344
X_7	.345*	.339	.281	.339	.106	.344	-.284	.344
X_8	-.091	.339	-.066	.339	-.049	.344	-.067	.344
X_9	-.053	.339	-.021	.339	.066	.344	.257	.344
X_{10}	--	.339	--	.339	.462*	.344	-.114	.344
R Squared	.47		.47		.64		.64	

*Significant at the .05 probability level.

rc = Calculated correlation coefficient.

rt = Correlation coefficient of significance (Snedecor and Cochran 1971).

R Squared = Square of multiple correlation coefficient.

-- = Not used in analysis.

Y_1 = Total number of elk observed during both summers of study.

Y_2 = Elk observed/acre of clearcut.

Y_3 = Percent of observations of clearcuts that resulted in a sighting of at least one elk.

Y_4 = Pellet groups of current years/acre.

X_1 = Shortest distance from the center of clearcut to Spring Creek Road; the area of greatest human disturbance (tenths of miles).

TABLE 17. Continued.

X_2 = Shortest distance from the edge of clearcut to a theoretical line drawn along the edge of the unbroken timber cover area (tenths of miles).

X_3 = Age of the clearcut (years).

X_4 = Amount of logging debris present (1, clean; 2, intermediate; 3, unclean).

X_5 = Size of opening; clearcuts plus adjoining burn and natural park area if any (acres).

X_6 = Moisture condition of clearcut (1, mesic; 2, intermediate; 3, xeric).

X_7 = Slope (1, <16; 2, 16-25; 3, 26-35; and 4, 36-45 percent).

X_8 = Elevation (hundreds of feet).

X_9 = Aspect (1, N; 2, NE; 3, E; 4, SE; 5, S; 6, SW; 7, W; 8, NW).

X_{10} = Size of clearcut (acres).

TABLE 18. SEX, AGE COMPOSITION, AND AVERAGE GROUP SIZE RECORDED FOR TWO WEEK INTERVALS FROM BOTH GROUND AND AIR (INCLUDES DUPLICATE OBSERVATIONS OF THE SAME INDIVIDUALS).

	Cows	Calves	Males		Unclassified	Total	No. Elk Groups Observed	Average Size of Group
			Yearlings	Older				
1971								
June 16-30	122	24	11	7	139	303	58	5.2
July 1-15	155	58	15	6	127	361	32	11.3
July 16-29	125	45	25	10	98	303	31	9.8
August 2-13	193	95	36	17	45	386	22	17.5
August 18-31	50	25	2	4	23	104	22	4.7
September 1-15	45	19	14	8	30	116	26	4.5
September 16-19	1	1	-	-	40	42	3	14
Total for 1971	691	267	103	51	502	1,615	194	
1972								
June 8-15	33	6	5	1	31	76	22	3.5
June 18-30	87	19	6	2	109	223	47	4.7
July 1-14	113	43	9	4	291	460	43	10.7
July 18-31	79	28	10	8	68	193	22	8.8
August 1-15	110	59	17	9	305	500	29	17.2
August 16-31	136	78	11	14	86	325	30	10.8
September 3-14	38	21	6	5	28	98	16	6.1
September 17-27	17	6	1	1	12	37	10	3.7
October 4-15	23	16	6	4	59	108	17	6.4
October 16-30	3	2	2	-	25	32	5	6.4
November 1-15	13	3	3	5	37	61	8	7.4
November 16-26	4	2	-	-	-	6	1	6
Total for 1972	656	283	76	53	1,051	2,119	250	

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